THE VALUE OF DRIED RUMEN LIQUOR CONCENTRATE IN DAIRY CALF RATIONS

By

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INTRODUCTION

Within the past ten years considerable study has been devoted to determining the feasibility and effects of the cud inoculation of young dairy calves (6, 7, 8, 14, 15, 16, 17, 27, 31, 33, 34, 35, 36). Commercial rumen inoculum material has recently become available in the feed trade, but little research has been conducted to determine the value of these materials with respect to rumen function and growth of calves.

The purpose of this study was to investigate further the value of rumen inoculation and to obtain more information as a guide for intelligent recommendations with respect to the practice of rumen inoculations using commercial, dried rumen liquor concentrates.

REVIEW OF LITERATURE

The stomach of the ruminant animal is quite different from that of the simple stomached animal such as the pig. The ruminant stomach has four distinct cavities with the larger cavity being the rumen which accounts for about 80% of the total capacity of the stomach (9).

Several research workers (18, 20, 26, 28, 37, 38) have spent considerable time studying the importance of the rumen in ruminant nutrition. It is known that the rumen functions as a storage and fermentation vat for ingested materials (28). It has been adapted to fill the particular needs of animals which feed on coarser feeds and roughages.

The breakdown of complex carbohydrates such as cellulose and hemicelluloses into utilizable products is a function of microflora and microfauna found in the rumen (9, 18). Baker and Harriss (3) state that protozoa offer only a functional and insignificant contribution to the digestion of cellulose in the normal animal, and that the disintegration of cellulose is chiefly a function of iodophilic forms of bacteria. Protozoa are involved with the digestion of starch (2).

Johnson et al. (23) proposes that most of the food nitrogen, whether protein or non-protein in nature, is synthesized by the bacteria into their own cellular proteins, that the protozoa utilize bacterial protein in their own growth, and that finally the host digests the protozoan protein and the remaining bacterial protein.

Two groups of hay flora and two groups of grain flora were described as follows:

Hay Flora

Group I - Quite large gram positive coccoids in closely knit pairs.

Group II - Large gram positive, fairly square-ended rods. Very large gram negative, cigar-shaped rods and smaller gram negative short rods in fours and multiples of four.

Grain Flora

Group I - Medium-sized, comparatively thin, gram positive rods.

Group II - Gram negative rods resembling coliform.

Information relative to the bacteria of the rumen of young calves has become of interest to several research workers in the past few years. Lengemann and Allen (25) conducted a study of the rumen contents of cattle of various ages and found that the newborn calf was without bacteria characteristic of the adult animal. These workers studied animals of six different age-ranges of 0 - 1 month, 1 - 2 months, 2 - 3 months, 5 - 6 months, 10 - 12 months and lactating cows over 2 years old. At least five animals from each group were sampled for the purpose of determining numbers of protozoa, total bacteria population, volume of rumen fluids, ability to digest cellulose and the more characteristic types of bacteria. The calves received up to 6.0 lb. of whole milk, fed twice daily, a 16% protein concentrate mixture at the rate of 3.0 lb. daily and grass hay. The adult animals received from 8.0 to 16.0 lb. of a 16% protein concentrate mix, 30.0 to 40.0 lb of corn

silage and 15.0 lb. of mixed hay. The types of bacteria found in the adult, 12 month and 6 month groups were chiefly organisms characteristic of a hay type diet, whereas the remainder of the animals showed a grain type of flora. The 1 and 2 month groups showed a scarcity of hay type bacteria. The flora of the 1 month old calves varied and few adult types of organisms were present. There was little digestion of cellulose because of the absence of cellulolytic organisms. The 2 to 3 month old groups showed transition toward the adult function and by the age of 6 months, few differences existed between the calves and the adult animals.

Huhtanen et al. (21) conducted investigations on the rumen flora of 200 calves from three states and 200 adult cattle from eight locations with all animals being fed practical rations. The types of organisms found in the rumen of the calves were quite different from those in the mature animals. These workers found that nine organisms characteristic of the rumen of calves' almost never occurred in the rumen of healthy, adult cattle eating a balanced ration. The most common types of organisms found in the calves' rumen were fast growing, lactic acid forming bacteria, which produced a low pH and heavy turbidity. Some adult types of organisms were observed in the calves as early as 2 months.

Kesler et al. (24) working with male Holstein calves of various ages on a sacrifice basis found that animals 6 weeks of age or older had rumen contents showing adult-like characteristics. These findings are in general agreement with those of Pounden et al. (30) who found that the rumen flora and fauna of calves were similar to those observed in cows in all but five of fifteen calves within 30 days of birth.

Pounden and Hibbs (33, 35) have proposed a reason for rumen micro-

organisms not becoming established in a calf until it is several weeks old, is the failure of the animal to ingest good roughage or a sufficiently high proportion of it in comparison to grain. Another reason is the failure of the calf's rumen to become inoculated with usual microflora and microfauna because of separation from older stock.

Hibbs and Pounden (17) proposed that dairy calves may be raised comparatively free from calfhood disease conditions if early development of rumen function is promoted. Conditions for such development are provided by the utilization of large amounts of good quality roughage, strict limitation of grain and milk and the inoculation of the calves' rumen with cud material from older animals. They proposed that calves should be inoculated with a small piece of cud material on the 7th, 14th, 21st and 28th days of age.

Pounden and Hibbs (34) gave cud material to six of twelve calves and found that protozoa were present in the samples from all six of the inoculated calves at 3 weeks of age and present in great numbers at 6 weeks of age, but were completely absent in the uninoculated calves. With an earlier trial (31) these workers placed 4-day-old calves on various systems of feeding in an effort to determine the influence of the ration and rumen inoculation on the establishment of certain microorganisms in the rumen. It was found that there was a definite influence by the type of feed ingested upon the establishment of organisms. As the ratio of grain to hay decreased, there were more grain type organisms present. Inoculations assisted in the establishment of protozoa in the rumens of calves eating either hay alone or both hay and grain. However, the establishment of varieties of organisms which were associated with the ingestion of grain was not assisted by inoculations.

Pounden and Hibbs (32) investigated the influence of the ratio of grain to hay in the ration upon rumen microorganisms of dairy calves. In this study they used 19 calves between 1 and 4.5 months of age. The calves received rations of alfalfa hay or grain alone, or various proportions of these. Rumen samples were examined microscopically. It was found that as the proportion of grain ingested approached quantities equal to the hay, a reduction of organisms belonging to the hay flora groups was apparent. Organisms associated with hay disappeared from the rumen samples when the ratio reached 3 parts of grain to 1 part of hay. Samples taken from calves on rations consisting of hay alone or high proportions of hay showed the hay group of organisms to be prevalent. However, apparent increases in the flora associated with hay ingestion was noticed when the addition of some grain to rations of hay alone was made. These workers suggested that this increase resulted from the eating of more balanced rations by the calves.

Conrad et al. (8) conducted a series of balance trials with Jersey calves to determine the effect of rumen inoculations on the digestibility of roughages. Five inoculated and five uninoculated calves were fed for 14 days on a ration of limited whole milk and alfalfa hay. The calves which were inoculated digested a significantly higher percentage of cellulose and dry matter than those calves which were not inoculated. Results indicated that cud inoculations aided in providing microorganisms to digest cellulose more efficiently, when roughage constituted the entire dry feed. It was also found that cud inoculations stimulated hay consumption at an earlier age.

Conrad and Hibbs (6) showed that cud inoculations increased the apparent digestibility of protein when a calf was fed a low protein,

poor quality ration. However, no difference in protein digestibility between the inoculated and uninoculated calves was noted when protein was increased through heavier grain feeding. It was found that inoculation did not effect nitrogen retention.

Pounden and Hibbs (36) studied the effects of the lack of characteristic rumen microorganisms upon the well being of young calves. Four uninoculated Jersey calves were segregated from older stock from birth until 6 months of age. Control calves were treated under the same conditions except that they received rumen inoculum. Results showed that all uninoculated calves lacked the usual rumen protozoa at 6 months of age; however, all calves developed large coccoid bacteria between the ages of 1 and 2 months. The difference in average bodyweight between the two groups at 6 months of age was only 5.5 lb. The uninoculated calves were "pot-bellied" and their hair coat was rough and not as well conditioned as inoculated calves.

Pellissier et al. (27) studied the effect of cud inoculations on growth and hay consumption. Twenty-four 3-day-old calves were allotted at random to six groups with one half of the calves in each group being inoculated with fresh cud material. The trial was 109 days in duration and was repeated to confirm results. It was shown that cud inoculations had no influence on rate of increase of bodyweight, heart girth measurements or height at withers. No advantage of cud inoculation on hay consumption was found when calves were fed at high levels of roughage.

Hibbs and Pounden (16) conducted a study dealing with the effect of cud inoculations on the plasma carotenoids, liver and blood vitamin A and plasma ascorbic acid level of young dairy calves. Calves from birth to 6 weeks of age were used for this study. Results indicated

that those calves which were inoculated showed no advantage over uninoculated calves as far as their plasma carotenoids levels were concerned. Cud inoculations were not shown to effect the blood or liver vitamin A levels and no significant differences in the plasma ascorbic acid level were noted. No difference could be detected between the calves which were inoculated and those that were not, so far as their gains in bodyweight were concerned. In an earlier trial these same workers (15) demonstrated that cud inoculations exerted no effect on the blood plasma carotenoids of young dairy calves, but found that inoculated calves maintained higher plasma ascorbic acid levels when alfalfa hay was the only dry feed.

The use of high roughage systems in combination with cud inoculations for early development of rumen function has received considerable attention.

Conrad and Hibbs (7) found with two trials, that cud inoculations in combination with high roughage systems did not materially affect the synthesis of thiamine as the ratio of hay to grain was varied. Results did show that the riboflavin and thiamine content of rumen liquor in calves which were eating no dry feed at the age of 13 days was increased fourfold by the time the calves were eating 0.7 lb. of dry feed per day at 36 days of age. These workers suggest that the ingestion of dry feed is the major stimulus for vitamin synthesis in the rumen of young calves.

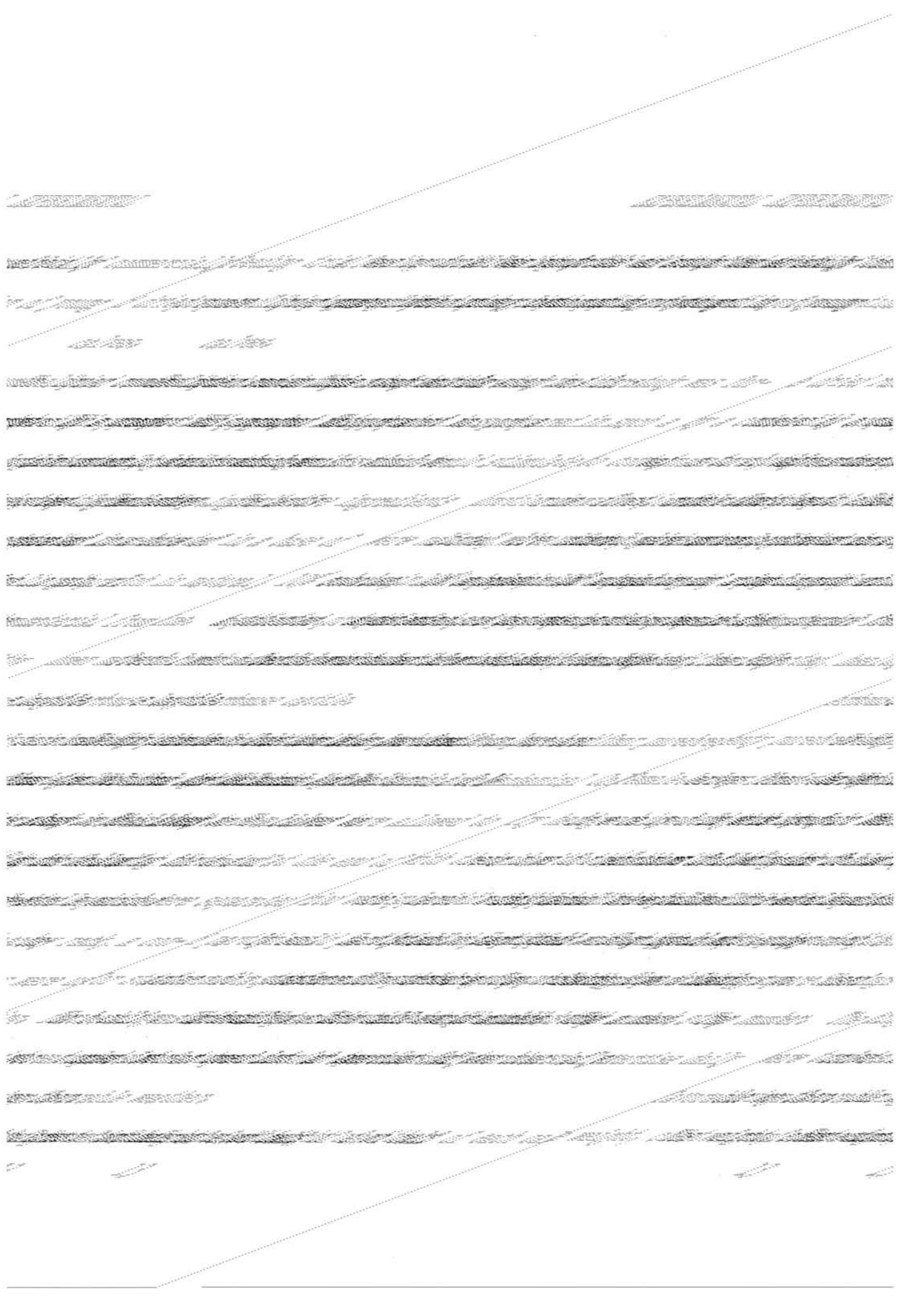
Hibbs *et al.* (14) have suggested that it may be of advantage to sacrifice some gain in bodyweight during the early months of a calf's life in order to obtain early mature type rumen function and thus take advantage of the economy of high roughage feeding. Growth, feed consumption and efficiency of feed utilization were studied during the

first 12 weeks in 21 rumen-inoculated calves. It was found that as the amount of grain was increased in proportion to the amount of hay there was an increase in weight gains, T. D. N. intake, efficiency of feed utilization and per cent of protein digested.

Pounden et al. (29) report that their work with commercially prepared rumen microorganisms and frozen fresh rumen contents proved to be of little value in establishing characteristic rumen microorganisms in young dairy calves. The frozen product was given in a drench once a week for 6 weeks and the commercial products were given through a stomach tube at similar intervals. The usual indicator microorganisms of the rumen were not found upon examination of the rumen contents of either group of calves at 1 month or 7 weeks of age. However, the indicator microorganisms were present in the rumen of cud inoculated calves on similar rations. It was noted that calves on the commercial and frozen product were in an unthrifty condition. Two other commercial products were tried on an older calf with similar results. Microscopic examination of the frozen product showed protozoa to be dead or seriously affected. The commercial products failed to reveal any of the indicator microorganisms normally present in rumen samples from mature dairy animals. In vitro studies with cellulose digestion showed that the frozen product was 80% as efficient and the commercial product 30% as efficient as fresh rumen juice.

Williams and Jensen (40) using dried rumen contents in calf milk replacers found that these dried rumen contents had no effect on growth rates. Twenty-four 4-day-old calves of the Holstein and Guernsey breeds were used for this trial during a 10 week period. A balanced 16% digestible protein calf starter was fed ad libitum up to 6.0 lb. daily and

alfalfa hay was fed free choice for the entire trial. The dried rumen contents were made by drying fresh rumen contents and blood from healthy slaughter-house cattle and then mixing with Brewer's yeast, bone phosphate, sucrose, live bovine rumen culture, cobalt sulphate and stabilized vitamin A. The data indicated that this material had no effect upon growth rates when used with or without terramycin and vitamin B-12.



was determined on the day of birth and the two following days. These three separate weights and measurements were used to establish each calf's initial body size. The calves were weighed and measured weekly during the 26-week trial. Each calf was weighed and measured again on the last 3 days of the trial in order to establish the final body size.

In order to minimize time requirement and to simplify the recording of data, body measurements and weights were recorded and feed intakes and other observations summarized each Friday in a series of periods designated as 0 through 26. The trial period for each calf ending on the first Friday, designated as the zero period, was variable in length with seven or less days. Each period thereafter involved seven days, except the last period which had an odd number of days in accordance with the length of the zero period. Each calf was on trial for 26 weeks, until the age of 184 days. A total of 31 calves was screened for the trial between July 4 and December 17, 1955 in order that 24 calves could be divided into four groups which were comparable from the standpoint of sex, breed and size. Each of the treatment groups consisted of 3 Holstein males, 2 Holstein females and 1 Jersey female.

Treatments were assigned at random to the groups of calves as follows: calves in Group A were inoculated with rumen liquor concentrate and received 300 lb. of whole milk; Group B calves were not inoculated but received 300 lb. of whole milk; Group C calves were inoculated and received 400 lb. of whole milk; Group D calves were not inoculated but received 400 lb. of whole milk. In all other respects all the calves were managed and fed alike.

The dried rumen liquor concentrate was fed at the rate of 4.0 g. daily during the entire trial to each calf in groups A and C. The

inoculum was first mixed with the milk, but after the milk feeding period the material was incorporated with the starter.

All calves were fed Holstein herd milk from nipple pails at the level of 1.0 lb. per 10.0 lb. of bodyweight until a maximum of either 300 or 400 lb. was reached. Caution was taken to assure that each calf used a separate nipple pail to avoid inoculum contamination of the control calves.

Each calf was offered good quality prairie hay free-choice from the beginning of the trial. The amount of hay eaten was determined carefully each day.

A starter was fed from the beginning of the trial and was offered free-choice until a maximum of 4.0 lb. was consumed daily. The amounts eaten prior to maximum consumption were determined daily. The calf starter used had the following ingredients: cracked corn, 40%; crimped oats, 15%; cottonseed meal, 20%; dried skimmilk, 15%; alfalfa meal, 10%; and salt, steamed bone meal and finely ground limestone, 1% each.

RESULTS AND DISCUSSION

Data relative to the response of the calves to the various treatments are summarized in Tables 1 through 5 and presented in detail in Appendix Tables I through XXIV. Table 1 shows the average weight gains and Table 2 the gains in height at withers and heart girth exhibited by the groups of calves. Table 3 lists the average starter consumption by periods, and in Table 4 the hay consumption is presented in the same manner. In Table 5 are summarized some of the major observations with respect to all of the inoculated versus the uninoculated calves.

Very little difference in average initial bodyweight existed between any of the groups. The average daily gains of groups A and B receiving 300 lb. of milk were very close during the milk feeding period whereas Group D had an average daily gain of 0.11 lb. greater than that of Group C. The apparent faster growth in Group D than in C may have been partially due to a better tolerance of the rate at which the milk was fed. This difference may not be of particular importance, however, in light of the individual variations among the calves of the groups involved. Groups C and D both received 400 lb. of milk which accounts for the greater gain demonstrated by these calves during the milk feeding period than those in groups A and B.

The number of days that calves were on milk varied considerably within each group. Group A was on milk for a median of 41 days as compared to Group B with 45 days. The median for Group C was 49 days as compared to 44 days for Group D. Apparently groups A and D

tolerated the 10% milk consumption level better than groups B and C, but this was not related to any treatment. Group C required more days to consume its maximum allowance of milk than any other group. The median of days for groups B and D was almost the same even though Group D consumed 100 lb more milk than Group B. The high extreme from the median of each group was caused by the low rate of milk intake of the Jersey calves.

The difficulty of maintaining groups C and B on a constant consumption of milk at the 10% level is explained by the health record of these groups. Two calves in Group C suffered from intermittent cases of scours which necessitated a reduction in their daily milk consumption for considerable lengths of time. The Jersey calf in Group C remained in poor health throughout the entire trial with the result that its milk feeding period was spread over 63 days. Several times it was necessary to lower the milk consumption of 4 calves in Group B due to intermittent scours.

The average total bodyweight gain of Group B was 10.0 lb. greater than that of Group A while Group D showed 22.0 lb. greater gain than Group C. The average daily gains in bodyweight of all groups were considerably larger during the latter portion of the trial than during the first part. Both uninoculated groups exhibited the same average final bodyweight and average daily gains. Group C showed the smallest average daily gain in bodyweight of the four groups with differences between groups A, B and D being relatively small. The average daily gain of all inoculated calves was 0.09 lb. less than that of the uninoculated calves (Table 5).

Measurements of height at withers and heart girth were used as

Table 1

RESPONSE TO VARIOUS TREATMENTS IN TERMS OF GROWTH AS MEASURED BY BODYWEIGHT

Description	Group A Inoculated 300 lb. milk	Group B Uninoculated 300 lb. milk	Group C Inoculated 400 lb. milk	Group D Uninoculated 400 lb. milk
	Bodyweight			
	lb.	lb.	lb.	lb.
Av. initial bodyweight	86	87	86	87
Av. daily gain during milk feeding period	0.68	0.67	0.79	0.90
Av. final bodyweight	304	315	292	315
Av. total gain to 184 days of age	218	228	206	228
Av. daily gain	1.20	1.25	1.13	1.25

supplements to bodyweight in determining growth response to the various treatments. These data are summarized in Table 2. The average initial height at withers was principally the same in each of the groups. The increase of height at withers was found to be closely parallel to the gains in bodyweight in all groups. The four groups were very closely parallel in height of withers measurements during each period of the trial with perhaps a small advantage in gains being demonstrated in groups B and D. Group B showed a minor increase over Group A while Group D exhibited an average total increase of 0.9 in. greater than that of Group C. In correlation with gains of bodyweight, Group C again showed the smallest average increase in height at withers of the four groups. As shown in Table 5, the average total increase of height at withers of all inoculated calves was 0.5 in. less than that of all uninoculated calves.

There was no difference in the average initial heart girth measurement between groups C and D. Group B had an average of 0.4 in. greater initial heart girth measurement than Group A. The gradual increases in heart girth measurements were very similar in all groups. Those slight differences which did exist were shown to be in the favor of groups A and D. Group A showed an average total increase in heart girth measurement of 0.5 in. greater than Group B. This was contrary to observations relative to the bodyweight and height at withers made with these two groups. However, due to this relatively small difference between these two groups and the possibility of errors occurring while taking measurements, this amount would probably constitute no real difference. Group C demonstrated the smallest total increase in heart girth of any of the groups, in agreement with the observations relative to the other

Table 2

RESPONSE TO VARIOUS TREATMENTS IN TERMS OF GROWTH AS MEASURED BY HEIGHT AT WITHERS AND HEART GIRTH

	Group A Inoculated 300 lb. milk		Group B Uninoculated 300 lb. milk		Group C Inoculated 400 lb. milk		Group D Uninoculated 400 lb. milk	
	Height withers	Heart girth	Height withers	Heart girth	Height withers	Heart girth	Height withers	Heart girth
Description	Measurements							
	in.	in.	in.	in.	in.	in.	in.	in.
Av. initial measurements	28.3	28.4	28.3	28.8	28.4	28.9	28.4	28.9
Av. final body measurements	37.8	44.1	38.3	44.1	37.8	43.7	38.7	44.4
Av. total gain to 184 days of age	9.5	15.8	9.9	15.3	9.4	14.8	10.3	15.5

measurements of growth concerning Group C. Increases in heart girth measurements were comparable between groups C and D until the beginning of the 15th period when Group D began to exhibit somewhat greater increases. Group D continued to maintain larger heart girth measurements throughout the remainder of the trial. It is shown in Table 5 that the average increase of heart girth measurements to 184 days of age of all inoculated and uninoculated calves were principally the same.

Starter consumption as related to various treatments is shown in Table 3. Group B consumed a slightly greater average amount of starter than Group A during the milk feeding period; however, this difference was no longer evident shortly following the end of milk feeding. The starter consumption of Group C was slightly greater than that of Group D during the milk feeding period but those periods which followed showed no particular differences in starter consumption between these two groups. Although Group D was longer in reaching the maximum daily allowance of 4.0 lb. than Group C, the small difference between the two groups is not especially noteworthy. All groups were approaching maximum consumption at the end of the 11th period. The total starter consumption as shown in Table 5 of all inoculated calves was slightly less than that of the uninoculated calves.

The hay consumption of each group was an important criterion in the evaluation of the effect of rumen inoculations upon early development of the calf's rumen. Average hay consumption of each group by periods is shown in Table 4. Hay consumption was very small in all groups during the first five periods of the trial. The differences between all groups in consumption during these five periods have little or no meaning due

Table 3

AVERAGE STARTER CONSUMPTION OF GROUPS AS RELATED TO RESPONSE OF VARIOUS TREATMENTS

	Group A Inoculated 300 lb. milk	Group B Uninoculated 300 lb. milk	Group C Inoculated 400 lb. milk	Group D Uninoculated 400 lb. milk
	Starter Consumption			
Periods	lb.	lb.	lb.	lb
0	0.3	0.4	0.7	0.4
1	0.9	1.6	2.1	1.2
2	2.7	4.4	4.2	3.4
3	3.7	6.5	6.2	4.6
4	5.6	8.7	7.4	6.5
5	6.5	8.9	7.9	7.1
6	11.5	10.5	9.3	8.9
7	17.1	14.1	13.6	16.8
8	22.5	22.4	19.9	19.9
9	25.0	25.9	24.0	23.5
10	26.1	25.7	24.9	26.4
11	27.6	27.4	27.9	27.6
12	28.0	28.0	28.0	26.7
13	28.0	28.0	25.9	27.0
14	28.0	28.0	27.6	27.4
15	28.0	28.0	28.0	27.3
16	28.0	28.0	28.0	27.7
17	28.0	28.0	28.0	28.0
18	28.0	28.0	28.0	28.0
19	28.0	28.0	28.0	28.0
20	28.0	28.0	28.0	28.0
21	28.0	28.0	28.0	28.0
22	28.0	28.0	28.0	28.0
23	28.0	28.0	28.0	28.0
24	28.0	28.0	28.0	28.0
25	28.0	28.0	28.0	28.0
26	28.0	28.0	28.0	28.0

Table 4

AVERAGE HAY CONSUMPTION OF GROUPS BY PERIODS AS RELATED TO RESPONSE OF VARIOUS TREATMENTS

	Group A Inoculated 300 lb. milk	Group B Uninoculated 300 lb. milk	Group C Inoculated 400 lb. milk	Group D Uninoculated 400 lb. milk
	Hay Consumption			
Periods	lb.	lb.	lb.	lb.
0	0.09	0.06	0.05	0.03
1	0.01	0.10	0.03	0.05
2	0.4	0.2	0.1	0.1
3	1.0	0.5	0.4	0.4
4	1.0	0.7	1.0	0.6
5	1.9	1.2	1.1	1.2
6	2.7	2.6	1.9	1.2
7	3.0	4.5	3.1	2.5
8	4.2	4.3	4.3	4.5
9	4.2	5.7	5.0	6.2
10	5.1	7.7	5.9	7.4
11	8.9	11.4	8.5	11.3
12	11.6	12.9	9.9	14.5
13	15.6	19.5	10.3	16.3
14	19.6	20.7	15.0	19.9
15	21.7	25.6	18.2	22.7
16	25.7	28.3	18.0	25.6
17	27.5	28.9	22.0	28.5
18	30.2	30.9	25.5	31.3
19	34.0	35.7	24.4	32.9
20	36.6	36.8	28.8	37.1
21	38.7	38.2	31.7	39.3
22	41.0	43.5	33.1	41.4
23	41.0	46.9	39.0	43.0
24	47.0	49.5	37.5	48.3
25	46.1	53.5	38.3	50.6
26	53.4	55.0	45.9	49.5

to the small amounts consumed. Following the end of the milk feeding period, a gradual increase in hay consumption was noted in all groups. The amounts of hay consumed in groups A and B were relatively parallel from the 6th period to the end of the 26th period, with Group B having a slightly greater average level of consumption. No particular difference in hay consumption seemed to exist between groups C and D until the end of the 9th period when an appreciable difference became apparent. At this time Group D began to consume larger amounts of hay than Group C and continued to do so throughout the remainder of the trial. Group B exhibited the largest total consumption of hay of the four groups. The total hay consumption of Group C was 685.3 lb. less than that of Group D. As shown in Table 5, the total hay consumption of all uninoculated calves was considerably greater than that of the inoculated calves.

The results of this study show that the groups that were fed milk most liberally maintained the greatest average daily gain during the milk feeding period regardless of treatments. Groups A and D demonstrated the best tolerance of the level of milk fed with Group C requiring the greatest amount of time to consume its total milk allowance. The average daily gain of all inoculated calves was less than that of the uninoculated calves. The increase of height at withers was found to be closely parallel to the gains in bodyweight of all groups. The average total increase of height at withers of inoculated calves was found to be less than that of the uninoculated calves. The average total increases in heart girth measurements were very similar in all groups. Group C exhibited the smallest total increase of the four groups which was in agreement with the findings of all other measurements of growth concerning this group. No particular difference in average heart

Table 5

SUMMARY OF OVER-ALL RESPONSE OF INOCULATED AND UNINOCULATED GROUPS

Description	Inoculated (Groups A and C)	Uninoculated (Groups B and D)
Av. initial bodyweight (lb.)	86	87
Av. initial heart girth measurements (in.)	28.6	28.8
Av. initial height at withers (in.)	28.3	28.3
Av. total gain in weight to 184 days of age (lb.)	212	228
Av. daily bodyweight gains (lb.)	1.16	1.25
Av. increase of height of withers measurements to 184 days of age (in.)	9.5	10.0
Av. increase of heart girth measurements to 184 days of age (in.)	15.3	15.4
Total starter consumption for 182 days on trial (lb.)	6,601.1	6,653.3
Total hay consumption for 182 days on trial (lb.)	5,358.5	6,288.1
Median days on milk (da.)	44	44

girth measurement was noted between all inoculated and uninoculated calves. On the basis of this study it appears that the inoculum material used did not exert a beneficial effect upon the growth, health or milk tolerance of young dairy calves.

Starter consumption varied considerably between groups and between individuals of each group. Total starter consumption of the inoculated calves was found to be slightly less than that of the uninoculated calves. The total hay consumption of all inoculated calves was 929.6 lb. less than that of uninoculated calves. Group B exhibited the largest total hay consumption while Group C showed the smallest total consumption of the four groups. It was apparent that rumen inoculations failed to exert any beneficial influence on earlier consumption of hay or starter. Also the inoculum material failed to demonstrate an influence on greater total consumption of hay and starter by young dairy calves.

SUMMARY AND CONCLUSIONS

A feeding trial was conducted to study the effect upon young dairy calves of rumen inoculations with commercial dried rumen liquor concentrate.

Twenty-four calves of the Holstein and Jersey breeds were used in a 26-weeks study. The calves were divided into four comparable groups from the standpoint of size, sex and breed. Calves in groups A and B each received 300 lb. of milk, with Group A being inoculated and Group B serving as uninoculated controls. The calves in groups C and D each received 400 lb. of milk with Group C being inoculated and Group D not inoculated. Milk was fed at the rate of 10% of bodyweight to all calves. The dried rumen liquor concentrate was fed at the rate of 4.0 g. daily during the entire trial, first with the milk and later with the starter. Prairie hay was fed free-choice and starter was limited to a maximum daily allowance of 4.0 lb..

Response to the various treatments was measured in terms of growth and feed consumption with observations of health and milk tolerance being recorded.

The results of this study show that the higher milk intake groups maintained the greatest average daily gain during the milk feeding period regardless of treatments. The median of days that each group required to consume its respective allowance of milk varied, depending upon the health of the individual calves in each group. Apparently the inoculum material did not exert a beneficial effect upon the health or

milk tolerance of young dairy calves.

The average total bodyweight gains and average total increases of height at withers of all inoculated calves was found to be less than that of the uninoculated calves. The average total increase of heart girth measurement of all inoculated and uninoculated calves was principally the same. On the basis of these findings it is concluded that the inoculum material did not exert a beneficial influence upon the growth of young dairy calves.

The total starter consumption of all inoculated calves was slightly less than that of the uninoculated with no indication of increased early consumption being noted in the inoculated groups.

Inoculations were not found to exert a beneficial influence upon earlier or greater consumption of hay by young calves. The total hay consumption of all inoculated calves was considerably less than that of the uninoculated calves.

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A P P E N D I X

APPENDIX

TABLES

TABLE I

Calf No. 51, H. Female — Treatment A

Born 7/6/55 — On trial 7/8/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	82	29.0	27.5	-	-
0	3	81	29.0	27.5	-	0.1
1	10	87	29.5	28.0	0.5	-
2	17	92	29.5	28.0	1.4	0.3
3	24	93	30.0	28.5	2.3	0.8
4	31	103	31.0	29.0	3.0	1.1
5	38	109	32.0	30.0	4.9	1.6
6	45	120	32.5	30.0	13.8	1.8
7	52	118	33.0	30.0	16.6	1.3
8	59	133	34.0	30.5	15.5	2.9
9	66	131	34.5	30.5	15.5	5.0
10	73	139	34.5	30.5	19.5	5.2
11	80	142	35.0	30.5	23.5	8.2
12	87	155	35.5	31.0	26.5	9.7
13	94	169	36.0	31.0	28.0	12.6
14	101	172	36.5	31.5	28.0	17.9
15	108	170	37.0	32.0	28.0	11.1
16	115	181	37.5	32.0	28.0	11.4
17	122	195	38.0	32.5	28.0	23.9
18	129	205	38.5	33.0	28.0	31.1
19	136	212	39.0	33.5	28.0	27.1
20	143	216	40.0	33.5	28.0	31.9
21	150	228	40.0	33.5	28.0	28.9
22	157	240	40.0	34.0	28.0	25.0
23	164	240	40.5	34.5	28.0	29.9
24	171	260	41.0	35.5	28.0	35.2
25	178	264	41.5	35.5	28.0	33.9
26	184	268	42.5	36.0	24.0	32.7

TABLE II

Calf No. 140, H. Female — Treatment A

Born 8/16/55 — On trial 8/18/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	95	29.0	28.5	-	-
0	4	94	29.0	28.5	0.3	0.1
1	11	84	29.0	29.0	0.3	-
2	18	82	29.0	29.0	2.2	0.8
3	25	97	30.5	30.0	4.1	1.3
4	32	104	31.0	30.0	6.1	2.3
5	39	115	31.0	30.5	7.4	3.3
6	46	122	33.0	31.0	11.6	3.7
7	53	133	34.0	31.5	24.0	5.9
8	60	141	35.0	32.0	28.0	5.1
9	67	147	35.5	32.0	26.8	4.2
10	74	152	36.0	32.0	25.6	2.1
11	81	160	36.5	32.5	28.0	9.4
12	88	170	36.5	33.0	28.0	15.7
13	95	180	37.0	33.5	28.0	18.0
14	102	190	38.0	34.0	28.0	24.3
15	109	200	38.5	34.5	28.0	24.9
16	116	209	38.5	34.5	28.0	30.9
17	123	215	39.0	35.0	28.0	21.5
18	130	230	40.0	35.0	28.0	31.4
19	137	242	40.0	35.5	28.0	28.6
20	144	241	40.5	35.5	28.0	42.8
21	151	272	41.0	36.0	28.0	46.2
22	158	283	41.5	37.0	28.0	49.8
23	165	295	42.0	37.5	28.0	46.0
24	172	300	42.0	37.5	28.0	56.5
25	179	314	43.0	37.5	28.0	51.4
26	184	327	44.0	38.5	20.0	35.2

TABLE III

Calf No. 201, J. Female — Treatment A

Born 8/25/55 — On trial 8/27/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	56	25.0	25.0	-	-
0	9	51	25.0	25.5	0.3	0.1
1	16	53	25.0	26.0	0.7	-
2	23	52	25.5	26.0	1.8	-
3	30	56	25.5	26.5	2.2	0.4
4	37	62	26.0	27.0	5.9	0.6
5	44	75	27.5	27.0	8.0	1.4
6	51	75	29.0	28.0	9.0	1.0
7	58	81	30.0	28.5	8.1	1.9
8	65	90	31.5	28.5	20.8	2.0
9	72	98	31.5	29.0	26.9	2.5
10	79	107	32.0	29.5	28.0	4.1
11	86	112	32.5	30.5	28.0	6.0
12	93	116	33.5	31.0	28.0	8.0
13	100	126	33.5	31.0	28.0	7.7
14	107	132	34.0	31.5	28.0	12.2
15	114	140	35.0	32.0	28.0	12.2
16	121	150	35.5	32.0	28.0	14.3
17	128	151	35.5	32.5	28.0	12.3
18	135	143	35.5	32.5	28.0	16.1
19	142	165	36.0	33.0	28.0	16.2
20	149	170	36.0	33.0	28.0	18.1
21	156	183	37.0	33.5	28.0	20.8
22	163	168	37.5	33.5	28.0	16.0
23	170	192	38.0	34.0	28.0	23.5
24	177	198	38.0	34.5	28.0	24.0
25	184	214	39.5	35.0	28.0	17.9

TABLE IV

Calf No. 24, H. Male — Treatment A

Born 8/28/55 — On trial 8/30/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	96	28.5	30.0	-	-
0	6	100	30.0	30.0	-	-
1	13	95	30.0	30.0	1.7	0.1
2	20	102	30.5	31.0	3.9	0.2
3	27	104	31.0	31.0	5.6	0.9
4	34	110	31.5	32.0	5.5	0.8
5	41	120	32.0	32.0	4.5	1.3
6	48	119	33.0	32.5	9.7	4.1
7	55	128	33.0	32.5	13.7	6.9
8	62	130	34.0	32.5	17.7	8.5
9	69	133	35.0	33.0	24.6	8.1
10	76	150	36.0	33.5	27.7	11.1
11	83	160	36.0	33.5	28.0	11.5
12	90	157	36.5	33.5	28.0	7.1
13	97	155	37.0	34.0	28.0	10.3
14	104	169	37.5	34.5	28.0	12.0
15	111	182	37.5	35.0	28.0	14.7
16	118	192	39.0	35.0	28.0	18.6
17	125	207	39.0	36.0	28.0	25.7
18	132	212	39.5	36.0	28.0	31.5
19	139	224	40.0	36.5	28.0	40.3
20	146	228	40.5	36.5	28.0	33.8
21	153	246	41.0	37.0	28.0	32.6
22	160	257	41.5	37.0	28.0	42.6
23	167	276	42.0	37.5	28.0	44.9
24	174	285	43.0	37.5	28.0	50.0
25	181	288	43.5	38.5	28.0	55.3
26	184	300	45.0	39.0	12.0	24.7

TABLE V

Calf No. 69, H. Male — Treatment A

Born 8/31/55 — On trial 9/2/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

	Growth				Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	98	30.0	30.0	-	-
0	3	97	30.0	30.0	-	-
1	10	89	30.0	30.0	0.9	-
2	17	93	30.0	30.0	3.1	-
3	24	101	31.0	30.5	5.8	0.2
4	31	110	31.0	30.5	7.0	-
5	38	125	32.5	31.0	7.0	-
6	45	121	33.5	31.5	12.0	0.5
7	52	128	34.5	32.0	25.5	0.3
8	59	144	35.0	32.5	28.0	0.1
9	66	155	36.0	33.0	28.0	0.4
10	73	167	36.0	33.0	28.0	0.6
11	80	165	36.0	33.5	28.0	0.9
12	87	168	36.5	34.0	28.0	2.9
13	94	174	37.0	34.0	28.0	15.7
14	101	191	38.0	34.5	28.0	20.0
15	108	202	38.5	34.5	28.0	26.9
16	115	213	39.0	35.0	28.0	30.9
17	122	228	39.5	35.5	28.0	35.1
18	129	210	39.5	36.0	28.0	31.5
19	136	240	40.0	36.5	28.0	42.3
20	143	254	40.0	36.5	28.0	45.7
21	150	275	41.5	36.5	28.0	48.2
22	157	286	42.0	37.0	28.0	57.3
23	164	307	42.0	37.0	28.0	60.0
24	171	328	43.0	37.5	28.0	65.7
25	178	325	44.0	38.0	28.0	68.8
26	184	351	46.5	38.5	24.0	59.6

TABLE VI

Calf No. 170, H. Male — Treatment A

Born 12/15/55 — On trial 12/17/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	86	29.0	29.0	-	-
0	9	95	29.5	29.5	0.5	-
1	16	93	30.0	29.5	1.3	-
2	23	95	31.0	30.5	3.8	1.3
3	30	110	32.0	30.5	2.0	2.6
4	37	110	32.5	31.0	6.1	1.1
5	44	121	33.0	31.5	7.0	3.7
6	51	133	34.0	32.5	13.0	5.3
7	58	150	34.5	33.0	14.6	1.7
8	65	160	35.0	33.5	25.0	6.5
9	72	170	36.0	34.0	28.0	5.2
10	79	188	37.5	34.0	28.0	7.5
11	86	195	38.0	34.5	28.0	17.6
12	93	211	39.0	35.5	28.0	24.5
13	100	220	40.0	36.0	28.0	29.1
14	107	225	41.0	36.0	28.0	31.4
15	114	246	41.5	36.5	28.0	40.6
16	121	265	42.0	36.5	28.0	47.9
17	128	275	42.0	37.0	28.0	46.6
18	135	282	43.0	37.0	28.0	39.3
19	142	297	44.0	38.0	28.0	49.3
20	149	300	44.0	38.5	28.0	47.2
21	156	311	45.0	39.0	28.0	55.7
22	163	325	45.5	39.5	28.0	55.3
23	170	350	47.0	39.5	28.0	41.5
24	177	355	47.5	40.0	28.0	50.3
25	184	362	47.5	40.0	28.0	49.1

TABLE VII

Calf No. 89, H. Male — Treatment B

Born 7/28/55 — On trial 7/30/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	101	30.5	30.5	-	-
0	9	99	30.5	30.5	0.1	0.1
1	16	100	30.5	30.5	1.8	0.1
2	23	113	31.0	30.5	7.6	0.7
3	30	113	31.5	31.0	6.5	0.6
4	37	132	32.0	31.5	10.4	1.8
5	44	145	33.5	32.0	12.1	2.0
6	51	150	34.0	32.0	9.5	4.4
7	58	154	35.0	32.5	11.5	13.2
8	65	159	35.0	32.5	19.3	8.6
9	72	175	35.5	33.0	26.5	9.4
10	79	176	36.0	33.5	28.0	13.9
11	86	186	36.5	34.0	28.0	13.5
12	93	194	38.0	34.0	28.0	18.0
13	100	196	38.5	34.5	28.0	19.8
14	107	217	38.5	34.5	28.0	33.0
15	114	227	39.5	35.0	28.0	31.3
16	121	238	40.0	35.5	28.0	32.1
17	128	237	40.5	36.0	28.0	25.9
18	135	240	40.5	36.0	28.0	32.1
19	142	267	41.0	36.5	28.0	34.9
20	149	262	42.0	37.0	28.0	34.2
21	156	280	43.0	37.0	28.0	38.2
22	163	290	43.0	37.5	28.0	43.3
23	170	313	43.0	38.0	28.0	46.9
24	177	324	44.0	38.5	28.0	47.9
25	184	333	44.5	39.5	28.0	50.0

TABLE VIII

Calf No. 42, H. Male — Treatment B

Born 8/6/55 — On trial 8/8/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

	Growth				Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	86	29.5	28.5	-	-
0	7	78	29.0	28.5	1.3	0.1
1	14	84	29.5	28.5	3.2	0.4
2	21	91	30.0	29.0	4.9	0.2
3	28	97	30.0	29.5	6.7	1.0
4	35	109	31.0	30.0	8.6	1.5
5	42	117	32.0	30.5	10.4	2.7
6	49	125	33.0	31.5	14.8	6.3
7	56	136	33.5	32.0	20.0	7.1
8	63	146	34.5	32.0	25.2	7.8
9	70	140	35.0	32.0	28.0	10.7
10	77	147	35.5	32.5	28.0	12.5
11	84	160	36.0	32.5	28.0	12.6
12	91	170	37.0	33.0	28.0	15.2
13	98	180	37.5	33.5	28.0	20.5
14	105	189	38.0	34.0	28.0	19.7
15	112	197	38.5	34.5	28.0	36.7
16	119	205	39.0	34.5	28.0	36.1
17	126	217	39.5	35.0	28.0	28.8
18	133	223	40.5	35.5	28.0	37.2
19	140	232	41.0	36.0	28.0	32.7
20	147	253	41.5	36.5	28.0	30.4
21	154	247	42.0	37.0	28.0	35.2
22	161	262	42.5	37.0	28.0	39.8
23	168	280	42.5	37.5	28.0	40.8
24	175	284	43.0	38.0	28.0	44.6
25	182	306	43.5	38.0	28.0	53.1
26	184	315	44.0	38.5	8.0	14.7

TABLE IX

Calf No. 1, H. Female — Treatment B

Born 8/24/55 — On trial 8/26/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	83	29.0	29.0	-	-
0	3	86	29.0	29.0	-	-
1	10	79	29.0	29.0	0.5	0.1
2	17	81	29.5	29.5	1.6	-
3	24	78	29.5	30.0	5.5	-
4	31	92	30.0	30.0	8.8	-
5	38	94	30.0	30.5	3.9	0.2
6	45	106	31.0	31.0	4.5	2.0
7	52	113	31.5	31.5	9.7	2.3
8	59	125	33.0	32.0	22.2	2.2
9	66	126	33.5	32.0	24.1	2.9
10	73	138	34.5	32.5	28.0	3.7
11	80	151	35.0	32.5	28.0	8.8
12	87	156	35.0	33.0	28.0	12.0
13	94	164	35.5	33.5	28.0	14.2
14	101	169	36.0	34.0	28.0	13.0
15	108	178	37.0	34.5	28.0	21.1
16	115	189	37.5	34.5	28.0	21.6
17	122	200	38.0	35.0	28.0	24.4
18	129	206	38.5	35.0	28.0	24.2
19	136	211	39.0	36.0	28.0	30.5
20	143	234	39.5	36.0	28.0	36.3
21	150	242	40.0	36.5	28.0	35.4
22	157	250	40.5	37.0	28.0	34.7
23	164	256	40.5	37.5	28.0	38.0
24	171	266	41.0	38.0	28.0	41.5
25	178	276	41.5	38.5	28.0	42.7
26	184	292	43.5	39.0	24.0	39.2

TABLE X

Calf No. 19, H. Male — Treatment B

Born 8/29/55 — On trial 8/31/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	97	29.5	27.5	-	-
0	5	95	29.5	28.0	-	-
1	12	94	29.5	29.0	1.2	-
2	19	97	30.0	29.0	5.8	-
3	26	101	30.5	29.5	9.5	0.5
4	33	107	31.0	29.5	9.5	0.2
5	40	116	31.0	30.0	7.0	1.6
6	47	116	32.0	30.0	10.0	1.0
7	54	129	33.0	31.0	13.0	0.7
8	61	135	34.0	31.0	24.7	2.5
9	68	144	34.5	31.0	28.0	2.6
10	75	159	35.0	31.5	28.0	4.0
11	82	160	35.0	32.0	28.0	3.6
12	89	160	35.5	32.5	28.0	2.1
13	96	174	36.0	32.5	28.0	14.6
14	103	179	36.5	33.0	28.0	19.2
15	110	190	37.0	33.0	28.0	22.3
16	117	202	37.5	33.5	28.0	26.3
17	124	214	38.0	34.0	28.0	35.2
18	131	215	38.5	34.5	28.0	29.8
19	138	250	39.0	34.5	28.0	38.5
20	145	251	39.5	35.0	28.0	36.7
21	152	268	40.0	35.0	28.0	39.2
22	159	276	40.5	35.5	28.0	47.1
23	166	297	41.5	36.0	28.0	46.8
24	173	316	42.0	36.5	28.0	55.0
25	180	319	43.0	36.5	28.0	59.0
26	184	342	45.0	37.0	16.0	36.1

TABLE XI

Calf No. 22, H. Female — Treatment B

Born 9/10/55 — On trial 9/12/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	94	28.5	28.5	-	-
0	7	94	29.0	29.0	-	-
1	14	94	29.0	29.0	2.2	-
2	21	103	30.0	29.5	3.5	-
3	28	112	30.5	30.0	3.5	-
4	35	110	32.0	30.0	6.5	0.3
5	42	122	33.0	31.0	9.2	-
6	49	138	33.5	31.5	11.2	0.3
7	56	139	34.0	32.0	17.0	1.4
8	63	160	35.0	32.0	27.5	1.9
9	70	163	35.5	32.5	28.0	1.7
10	77	155	36.0	33.0	14.1	3.8
11	84	175	36.5	33.0	24.5	16.8
12	91	182	37.0	33.5	28.0	15.2
13	98	186	37.5	34.0	28.0	30.0
14	105	183	37.5	34.0	25.6	12.2
15	112	205	38.0	34.5	28.0	25.1
16	119	200	38.5	34.5	28.0	28.7
17	126	208	39.0	35.0	28.0	28.4
18	133	225	39.5	35.5	28.0	24.6
19	140	235	39.5	35.5	28.0	35.2
20	147	245	40.0	35.5	28.0	41.8
21	154	265	40.0	36.0	28.0	35.3
22	161	280	41.5	36.5	28.0	50.1
23	168	290	41.5	37.0	28.0	59.0
24	175	310	43.5	37.5	28.0	58.1
25	182	322	44.0	37.5	28.0	62.5
26	184	331	44.0	37.5	8.0	18.7

TABLE XII

Calf No. 25, J. Female — Treatment B

Born 11/1/55 — On trial 11/3/55

Whole milk intake 300 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	59	26.0	26.0	-	-
0	4	64	26.5	26.5	-	-
1	11	59	27.0	27.0	0.9	-
2	18	65	28.0	27.5	2.8	-
3	25	65	28.0	28.5	7.0	1.0
4	32	76	29.0	29.0	8.4	0.5
5	39	81	29.0	29.0	10.9	0.4
6	46	92	30.0	29.5	12.9	1.3
7	53	98	31.0	30.0	13.1	2.0
8	60	105	32.0	30.5	15.2	3.0
9	67	103	32.5	31.0	20.5	6.7
10	74	121	33.0	31.5	28.0	8.0
11	81	128	33.5	32.0	28.0	12.9
12	88	137	34.5	32.0	28.0	15.1
13	95	144	35.0	32.5	28.0	17.6
14	102	161	35.5	32.5	28.0	27.3
15	109	170	36.5	33.0	28.0	26.8
16	116	180	37.5	34.0	28.0	35.0
17	123	190	38.5	34.5	28.0	30.6
18	130	205	39.0	34.5	28.0	37.7
19	137	225	41.0	34.5	28.0	42.6
20	144	236	41.5	35.0	28.0	41.4
21	151	229	42.0	36.0	28.0	46.1
22	158	250	42.5	36.5	28.0	45.9
23	165	263	43.0	37.0	28.0	49.6
24	172	263	43.5	37.0	28.0	50.1
25	179	275	44.0	38.0	28.0	53.7
26	184	275	44.0	38.0	20.0	40.4

Table XIII

Calf No. 60, H. Male — Treatment C

Born 7/3/55 — On trial 7/5/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

	Growth				Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	104	32.0	31.0	-	-
0	6	107	32.0	30.5	-	-
1	13	111	32.0	30.5	-	-
2	20	125	32.0	31.0	0.6	-
3	27	130	33.0	31.5	3.7	0.1
4	34	136	34.5	32.0	4.4	0.5
5	41	144	35.5	32.5	8.5	0.9
6	48	157	35.5	33.0	15.6	1.7
7	55	153	36.0	33.0	18.3	0.8
8	62	178	36.5	33.5	15.6	2.8
9	69	171	36.5	34.0	19.0	4.8
10	76	179	37.0	34.0	24.0	3.0
11	83	189	37.0	34.0	28.0	5.2
12	90	205	37.5	34.5	28.0	5.6
13	97	198	38.0	35.0	28.0	5.7
14	104	197	38.5	35.0	28.0	15.6
15	111	212	38.5	35.0	28.0	17.7
16	118	215	39.5	35.0	28.0	13.1
17	125	220	39.5	35.5	28.0	18.6
18	132	235	40.0	35.5	28.0	28.8
19	139	256	41.0	36.0	28.0	23.7
20	146	250	41.0	36.0	28.0	27.5
21	153	252	41.5	36.5	28.0	29.8
22	160	268	42.0	37.0	28.0	36.7
23	167	279	43.0	37.0	28.0	34.4
24	174	280	44.0	37.0	28.0	33.5
25	181	296	44.5	38.0	28.0	34.1
26	184	301	44.5	38.5	12.0	17.3

TABLE XIV

Calf No. 57, H. Male — Treatment C

Born 8/2/55 — On trial 8/4/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	81	29.5	29.0	-	-
0	4	79	29.5	29.0	-	-
1	11	76	30.0	29.0	1.1	0.2
2	18	85	30.5	29.0	3.7	0.3
3	25	91	31.0	29.5	3.9	0.2
4	32	102	31.5	30.0	5.4	1.5
5	39	112	33.0	30.5	6.0	1.1
6	46	121	33.5	31.0	8.2	2.4
7	53	135	34.0	31.5	8.7	4.0
8	60	139	36.0	32.0	15.4	6.4
9	67	156	36.5	32.5	26.5	6.1
10	74	161	37.0	33.0	28.0	8.7
11	81	166	38.0	33.5	28.0	8.6
12	88	170	38.5	33.5	28.0	4.8
13	95	180	38.5	34.0	28.0	9.1
14	102	200	39.0	34.5	28.0	18.6
15	109	195	39.0	35.0	28.0	19.7
16	116	201	39.5	35.0	28.0	19.8
17	123	209	40.0	35.5	28.0	23.3
18	130	215	40.0	36.0	28.0	25.1
19	137	228	41.0	36.0	28.0	26.7
20	144	238	42.0	36.5	28.0	26.4
21	151	250	42.0	37.0	28.0	28.6
22	158	250	42.5	37.5	28.0	38.2
23	165	275	43.0	37.5	28.0	46.2
24	172	270	43.0	37.5	28.0	38.4
25	179	278	44.0	38.0	28.0	39.8
26	184	301	45.0	39.0	20.0	35.8

TABLE XV

Calf No. 86, H. Female — Treatment C

Born 8/11/55 — On trial 8/13/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	81	28.5	27.0	-	-
0	9	79	28.5	27.5	0.3	0.2
1	16	82	29.0	28.0	1.6	-
2	23	85	29.0	28.0	2.1	0.3
3	30	95	30.0	28.5	2.7	1.1
4	37	100	30.5	29.0	3.2	2.5
5	44	111	31.0	29.0	4.1	1.4
6	51	117	32.5	30.0	5.7	3.1
7	58	132	33.0	30.5	7.7	7.7
8	65	142	34.0	31.0	23.0	8.2
9	72	151	34.5	31.0	28.0	9.0
10	79	161	36.0	31.5	28.0	8.3
11	86	172	36.5	32.0	28.0	15.6
12	93	192	37.0	32.5	28.0	23.9
13	100	193	37.5	33.0	28.0	20.7
14	107	198	38.0	33.5	28.0	24.5
15	114	212	38.5	33.5	28.0	26.8
16	121	222	39.0	34.0	28.0	30.9
17	128	240	39.5	34.5	28.0	35.2
18	135	252	40.5	35.0	28.0	36.5
19	142	265	41.0	35.0	28.0	32.9
20	149	271	41.5	36.0	28.0	44.0
21	156	286	41.5	36.0	28.0	46.4
22	163	297	42.0	36.5	28.0	44.2
23	170	313	42.5	36.5	28.0	47.6
24	177	320	43.0	37.0	28.0	56.7
25	184	329	44.0	37.5	28.0	49.9

TABLE XVI

Calf No. 13, H. Female — Treatment C

Born 8/22/55 — On trial 8/24/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	89	28.0	28.5	-	-
0	5	87	29.0	29.0	1.3	-
1	12	92	29.5	29.5	3.5	-
2	19	97	30.5	29.5	6.0	0.1
3	26	106	31.0	30.0	9.2	-
4	33	122	32.0	30.5	10.5	-
5	40	126	33.5	31.0	12.6	-
6	47	148	34.5	31.5	15.0	0.8
7	54	153	35.5	32.0	26.5	2.5
8	61	162	36.0	32.5	28.0	4.3
9	68	168	37.0	33.0	28.0	5.0
10	75	178	37.5	33.0	28.0	10.8
11	82	196	38.5	33.5	28.0	15.9
12	89	201	38.5	34.5	28.0	13.8
13	96	199	39.0	34.5	28.0	13.8
14	103	203	39.5	35.0	28.0	19.0
15	110	220	40.5	35.0	28.0	27.9
16	117	228	40.5	35.5	28.0	24.6
17	124	240	41.0	35.5	28.0	35.1
18	131	255	41.0	36.0	28.0	37.1
19	138	256	42.0	36.5	28.0	35.6
20	145	275	42.0	36.5	28.0	41.6
21	152	280	42.5	37.0	28.0	42.2
22	159	297	43.0	37.0	28.0	41.4
23	166	311	43.0	37.5	28.0	54.1
24	173	318	43.5	37.5	28.0	43.9
25	180	338	44.0	38.5	28.0	51.6
26	184	334	44.5	39.0	16.0	33.4

TABLE XVII

Calf No. 81, H. Male — Treatment C

Born 9/1/55 — On trial 9/3/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	99	30.0	30.0	-	-
0	9	81	30.0	30.5	0.6	-
1	16	99	30.5	30.5	3.7	-
2	23	103	31.0	30.5	9.4	0.1
3	30	112	32.0	31.0	11.9	0.7
4	37	128	33.5	31.5	13.7	1.2
5	44	128	34.0	32.0	11.4	2.0
6	51	132	34.5	32.5	6.2	1.6
7	58	140	34.5	32.5	12.7	2.3
8	65	142	35.5	33.0	25.5	3.0
9	72	161	36.0	33.5	28.0	4.1
10	79	164	36.5	34.0	28.0	3.1
11	86	165	37.0	34.0	28.0	4.5
12	93	174	37.0	34.5	28.0	9.0
13	100	179	37.5	35.0	28.0	10.7
14	107	185	38.0	35.5	28.0	8.3
15	114	187	38.0	35.5	28.0	8.9
16	121	194	38.5	35.5	28.0	9.8
17	128	186	38.5	36.0	28.0	12.8
18	135	212	39.0	36.0	28.0	15.3
19	142	218	39.0	36.5	28.0	16.9
20	149	218	39.5	37.0	28.0	19.2
21	156	236	40.0	37.5	28.0	25.8
22	163	242	40.5	38.0	28.0	22.4
23	170	248	41.0	38.0	28.0	30.6
24	177	264	42.0	38.0	28.0	32.3
25	184	296	44.0	38.0	28.0	31.5

TABLE XVIII

Calf No. 97, J. Female — Treatment C

Born 9/18/55 — On trial 9/20/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	60	25.0	25.0	-	-
0	6	52	25.0	25.0	0.1	-
1	13	57	26.0	25.5	2.6	-
2	20	72	27.0	26.0	3.5	-
3	27	67	28.0	26.5	5.5	0.3
4	34	75	29.0	27.0	7.0	0.5
5	41	81	29.0	27.0	4.7	1.3
6	48	81	29.0	28.0	4.8	1.5
7	55	90	30.0	29.0	7.5	1.5
8	62	100	30.5	29.5	11.5	1.3
9	69	101	31.0	30.0	14.6	0.9
10	76	103	32.0	30.0	13.2	1.4
11	83	110	32.0	30.0	27.5	1.3
12	90	118	32.5	30.5	28.0	2.1
13	97	115	33.0	31.0	15.1	1.8
14	104	118	33.0	31.0	25.6	4.1
15	111	115	33.5	31.0	28.0	8.2
16	118	127	33.5	31.5	28.0	9.7
17	125	129	34.0	32.0	28.0	6.8
18	132	131	35.0	32.0	28.0	10.1
19	139	140	36.0	32.0	28.0	10.7
20	146	152	36.0	32.5	28.0	14.3
21	153	153	36.0	32.5	28.0	17.2
22	160	160	37.0	33.0	28.0	15.9
23	167	170	37.5	33.5	28.0	20.8
24	174	175	38.0	34.0	28.0	20.0
25	181	187	39.5	34.5	28.0	22.6
26	184	192	40.0	35.0	12.0	11.9

TABLE XIX

Calf No. 74, H. Female — Treatment D

Born 7/6/55 — On trial 7/8/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	80	29.5	27.5	-	-
0	3	80	29.5	27.5	-	-
1	10	87	29.5	28.5	-	0.1
2	17	98	29.5	29.0	1.9	0.2
3	24	102	30.5	29.5	2.6	0.3
4	31	113	32.0	30.0	4.3	0.9
5	38	124	33.0	30.5	4.4	1.0
6	45	136	33.5	31.0	10.2	1.6
7	52	136	34.0	31.5	19.2	3.0
8	59	155	35.5	32.0	21.3	5.0
9	66	164	36.5	32.0	20.0	7.0
10	73	172	36.5	32.0	25.3	8.1
11	80	178	36.5	32.5	28.0	12.4
12	87	186	37.5	33.0	28.0	14.1
13	94	205	38.0	33.5	28.0	16.3
14	101	214	38.5	34.0	28.0	24.2
15	108	207	38.5	34.0	28.0	18.2
16	115	220	40.0	34.5	28.0	23.8
17	122	238	40.5	35.0	28.0	28.4
18	129	247	40.5	35.5	28.0	35.8
19	136	253	41.0	36.0	28.0	32.9
20	143	262	41.5	36.0	28.0	37.0
21	150	271	42.0	36.5	28.0	38.4
22	157	283	42.0	37.0	28.0	32.9
23	164	287	42.5	37.5	28.0	40.3
24	171	310	44.0	38.0	28.0	44.8
25	178	320	44.0	38.5	28.0	47.1
26	184	320	44.5	39.0	24.0	42.4

TABLE XX

Calf No. 84, J. Female — Treatment D

Born 7/17/55 — On trial 7/19/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	60	25.0	26.0	-	-
0	6	56	25.5	26.0	0.5	-
1	13	57	26.0	26.5	1.9	-
2	20	63	27.5	27.0	6.3	0.1
3	27	69	27.5	27.5	6.7	0.4
4	34	77	29.0	27.5	7.7	0.9
5	41	81	29.0	28.0	5.8	0.7
6	48	91	30.5	29.0	6.6	0.7
7	55	100	31.5	29.5	8.6	0.5
8	62	108	32.5	30.0	8.1	1.4
9	69	116	32.5	30.0	14.9	4.9
10	76	127	33.0	30.5	21.0	8.9
11	83	131	33.5	31.0	25.3	7.9
12	90	131	35.0	31.0	22.5	11.3
13	97	140	34.5	31.0	28.0	11.1
14	104	155	36.0	31.5	28.0	10.8
15	111	154	36.5	32.0	28.0	15.7
16	118	166	37.5	32.5	28.0	19.8
17	125	175	38.0	32.5	28.0	20.4
18	132	176	38.0	33.0	28.0	24.9
19	139	185	38.5	33.5	28.0	27.4
20	146	191	38.5	34.0	28.0	32.3
21	153	197	39.0	34.0	28.0	33.8
22	160	211	40.0	34.0	28.0	33.6
23	167	211	40.0	34.5	28.0	35.1
24	174	222	40.5	34.5	28.0	43.1
25	181	235	40.5	35.5	28.0	43.1
26	184	235	41.0	36.5	12.0	19.5

TABLE XXI

Calf No. 66, H. Male — Treatment D

Born 7/27/55 — On trial 7/29/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	102	30.5	29.0	-	-
0	3	102	30.5	29.0	-	-
1	10	94	30.5	29.5	0.5	0.1
2	17	99	30.5	29.5	1.9	0.2
3	24	105	31.5	30.0	3.9	1.0
4	31	116	32.5	31.0	5.6	1.1
5	38	130	33.5	31.5	7.5	2.6
6	45	137	34.5	32.0	9.2	2.5
7	52	147	35.0	32.5	12.1	4.4
8	59	151	35.5	33.0	18.3	10.3
9	66	163	36.0	33.0	24.0	9.3
10	73	180	37.0	33.5	28.0	11.1
11	80	187	37.0	34.0	28.0	16.6
12	87	196	38.5	34.5	28.0	16.2
13	94	205	39.5	35.0	28.0	15.8
14	101	214	40.0	35.0	28.0	18.6
15	108	233	40.0	35.5	28.0	29.4
16	115	238	40.5	36.0	28.0	31.5
17	122	245	41.0	36.5	28.0	36.8
18	129	257	42.0	36.5	28.0	31.3
19	136	272	42.5	37.5	28.0	32.6
20	143	286	43.0	38.0	28.0	38.7
21	150	300	43.5	38.0	28.0	39.5
22	157	311	44.0	38.5	28.0	44.8
23	164	317	44.0	39.0	28.0	44.9
24	171	340	45.0	39.5	28.0	54.7
25	178	354	46.0	39.5	28.0	63.0
26	184	358	46.5	40.5	24.0	57.1

TABLE XXII

Calf No. 39, H. Male — Treatment D

Born 8/14/55 — On trial 8/16/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	105	30.5	30.5	-	-
0	6	96	30.5	30.5	0.6	0.1
1	13	94	30.5	31.0	1.8	-
2	20	103	31.0	31.0	4.7	0.1
3	27	108	31.0	31.5	6.1	-
4	34	118	32.0	31.5	10.2	-
5	41	128	32.5	32.0	10.4	-
6	48	128	33.5	32.0	7.2	0.1
7	55	138	34.0	32.5	21.0	0.1
8	62	150	35.0	32.5	28.0	1.0
9	69	146	35.5	33.0	28.0	2.1
10	76	165	36.0	33.0	28.0	2.9
11	83	172	37.0	33.5	28.0	8.6
12	90	181	37.0	33.5	28.0	13.5
13	97	185	37.5	34.0	28.0	12.4
14	104	193	38.0	34.0	28.0	16.6
15	111	199	38.0	34.5	28.0	21.3
16	118	210	38.5	35.0	28.0	24.5
17	125	207	39.0	35.0	28.0	28.2
18	132	225	39.0	35.5	28.0	32.2
19	139	233	39.5	36.0	28.0	28.3
20	146	240	40.0	36.0	28.0	34.7
21	153	255	40.5	36.5	28.0	40.9
22	160	270	41.0	37.0	28.0	39.5
23	167	275	41.0	37.0	28.0	38.2
24	174	284	41.5	37.5	28.0	46.6
25	181	300	42.0	37.5	28.0	42.7
26	184	303	42.5	37.5	12.0	21.9

TABLE XXIII

Calf No. 110, H. Male — Treatment D

Born 8/27/55 — On trial 8/29/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	83	28.0	28.5	-	-
0	7	85	29.0	28.5	-	-
1	14	91	29.5	28.5	0.6	0.1
2	21	95	30.0	29.0	1.5	-
3	28	102	30.5	29.5	3.2	0.1
4	35	108	31.0	30.0	5.0	-
5	42	125	32.0	30.5	6.5	-
6	49	126	32.5	30.5	12.0	0.3
7	56	135	33.0	31.0	20.5	0.2
8	63	139	34.0	31.0	15.9	1.0
9	70	145	35.0	31.5	26.2	0.5
10	77	161	35.5	32.0	28.0	1.2
11	84	155	36.0	32.5	28.0	4.5
12	91	160	36.0	33.0	25.8	4.3
13	98	163	36.5	33.0	21.7	10.3
14	105	175	37.0	33.0	24.3	13.1
15	112	180	37.0	33.5	23.9	17.8
16	119	190	38.0	33.5	26.0	17.9
17	126	202	38.0	33.5	28.0	19.1
18	133	208	39.5	34.0	28.0	22.7
19	140	228	39.5	34.5	28.0	27.9
20	147	233	40.0	35.0	28.0	30.9
21	154	247	40.5	35.0	28.0	31.6
22	161	257	41.0	35.5	28.0	43.3
23	168	277	41.5	36.0	28.0	46.1
24	175	292	42.5	36.5	28.0	47.7
25	182	296	43.0	37.0	28.0	52.3
26	184	309	44.5	37.5	8.0	15.1

TABLE XXIV

Calf No. 95, H. Female — Treatment D

Born 12/9/55 — On trial 12/11/55

Whole milk intake 400 lb.

Growth Measurements and Feed Consumption by Periods

		Growth			Feed Intake	
Periods	Age	Bodyweight	Heart girth	Height withers	Starter	Prairie Hay
No.	Days	lb.	in.	in.	lb.	lb.
Initial	2	92	30.0	29.0	-	-
0	8	92	30.5	30.0	0.1	-
1	15	98	31.0	30.5	2.4	-
2	22	102	31.5	31.5	4.1	-
3	29	106	32.0	32.0	5.0	0.6
4	36	122	33.5	32.5	6.2	0.8
5	43	133	33.5	33.5	8.0	2.9
6	50	137	34.5	34.0	8.0	2.0
7	57	153	35.0	34.0	19.5	7.0
8	64	170	36.0	35.0	28.0	8.2
9	71	179	36.5	35.0	28.0	13.1
10	78	187	37.0	35.5	28.0	11.9
11	85	186	38.0	36.0	28.0	17.6
12	92	210	39.5	36.0	28.0	27.4
13	99	223	39.5	36.5	28.0	32.0
14	106	234	40.5	37.0	28.0	35.8
15	113	226	41.0	37.0	28.0	34.1
16	120	255	41.5	38.0	28.0	35.8
17	127	270	42.0	38.5	28.0	38.0
18	134	277	43.0	38.5	28.0	40.6
19	141	293	43.5	39.0	28.0	48.1
20	148	302	44.0	39.5	28.0	49.1
21	155	300	44.5	40.0	28.0	51.4
22	162	319	45.0	40.0	28.0	54.5
23	169	320	45.5	40.5	28.0	53.2
24	176	340	46.5	40.5	28.0	52.6
25	183	350	47.0	41.0	28.0	55.4
26	184	363	47.5	41.0	4.0	6.4

VITA

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